HYDROLOGIC MONITORING OF MCBAINE BOTTOMS, INCLUDING THE EAGLE BLUFFS CONSERVATION AREA

INTRODUCTION

The City of Columbia, Missouri and the Missouri Department of Conservation (MDC) in cooperation with the U.S. Geological Survey (USGS) have conducted water-quality monitoring and hydrologic monitoring in McBaine Bottoms (fig. 1) since 1992 to assess the effect of constructed wetlands on groundwater quality and flow. A significant conclusion resulting from analysis of data collected during the first few years of investigation was that inorganic compounds associated with sewage effluent in the wetlands could potentially migrate from the wetlands toward the city of Columbia municipal well field. Analysis of samples from as many as 32 monitoring wells in the vicinity of the wetlands and well field over the next few years conclusively showed that concentrations of calcium, chloride, potassium, sodium, and sulfate (indicator constituents) substantially changed in the groundwater beneath Eagle Bluffs Conservation Area and at treatment wetland unit l. Water-level measurements made during these years showed that the groundwater flow direction was radially away from the wetlands and that the effluent enriched groundwater had the potential to migrate toward the city of Columbia well field. Fifty-five groundwater level monitoring wells were installed in McBaine Bottoms in 2000. These wells were used in conjunction with the existing water-quality monitoring wells to provide a comprehensive monitoring-well network that could be used to map the groundwater surface and better interpret groundwater flow directions. Analysis of the data collected from these wells showed that water from the wetlands and treatment cells flows toward the city of Columbia well field (fig. 1).

In addition to increased concentrations of inorganic constituents, such as chloride, the effluent contains a variety of man-made organic compounds. In a sample collected in June 1999 from the effluent at treatment wetland unit 1 below the wastewater treatment outfall, several pharmaceutical and wastewater indicator compounds were detected. The compounds and concentrations, in micrograms per liter, included: cimetidine (stomach and intestinal ulcers), 3.53 (estimated); sulfamethoxazole (bladder infections), 1.02; gemfibrozil (high triglycerides), 0.556; NPEOI (surfactant), 2.0 (estimated); bisphenol A (epoxy resins and plastics), 3.2; ethanol,2-butoxy-phosphate (plastics), 3.2; and paranonylphenol (endocrine disruptor), 29.4 (estimated).

From 1999 through 2003, more than 35 wastewater indicator compounds and pesticides were detected in samples from the city outflow adjacent to treatment wetland unit 3. Most concentrations were estimated or their presence verified, but not quantified. In a sample from the city outflow collected in August 2007, 29 wastewater indicator compounds were detected; the presence 10 of the compounds was verified, but not quantified.

In 2003, groundwater sampling was focused on determining the presence or absence of about 70 wastewater indicator compounds such as caffeine, pharmaceuticals, cholesterol, hormones, polycyclic aromatic hydrocarbons (PAHs), and common household disinfectants. Some samples also were collected to analyze for a class of compounds broadly characterized as "emerging contaminants". These compounds include potential endocrine disruptor compounds

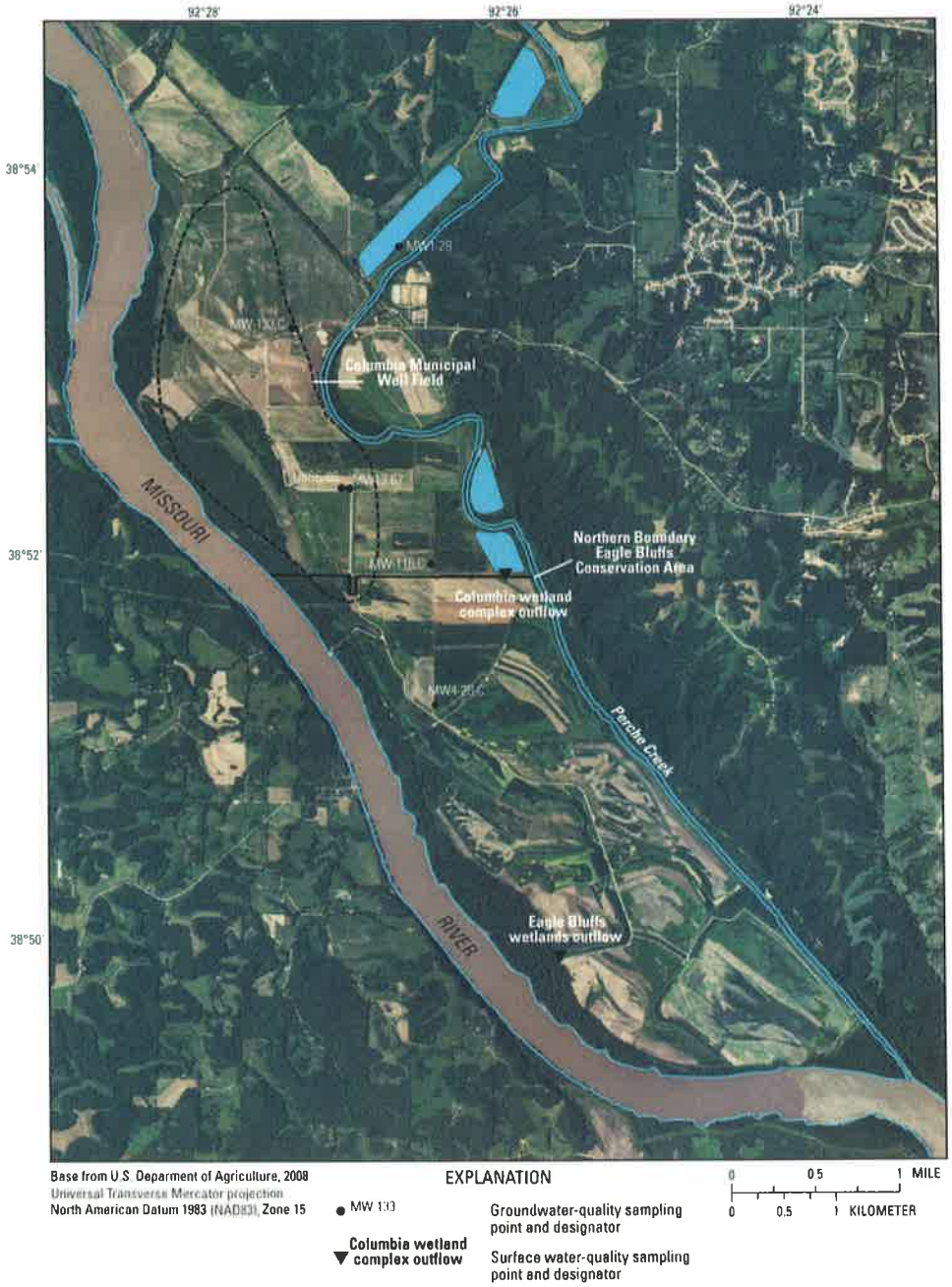

Figure 1. Location of water-quality sampling points in McBaine Bottoms, near Columbia, Missouri (Columbia wastewater treatment plant not shown on map).

that may modify the normal functioning of human and wildlife hormone systems and cause developmental, behavioral, and reproductive problems. Eleven wastewater indicator compounds were detected in samples from monitoring wells. Detected concentrations were estimated or their presence verified, but not quantified, except for atrazine concentrations of 0.007 and 0.008 microgram per liter and phenol concentrations that ranged from 0.5 to 1.8 micrograms per liter.

Previous work has identified that changes in groundwater chemistry are occurring because of the current operation of the wastewater treatment wetlands and practice of discharging treated sewage effluent on the Eagle Bluffs Conservation Area, and that this water can potentially reach the city of Columbia water-supply wells. Routine monitoring of selected monitoring wells located in critical areas will allow the tracking of long-term changes in water quality and groundwater flow. This information will enable city of Columbia water-resource managers to develop better well-field operational and contingency plans designed to continue protection of the well field.

Water samples were collected from 15 to 16 monitoring wells from 2005 through 2007. Samples were collected using standard USGS procedures by USGS Missouri Water Science Center personnel and analyzed at the USGS National Water Quality Laboratory in Denver, Colorado. To establish the flow conditions at the time of sampling, water-level measurements were made at the existing 87 groundwater monitoring sites. Samples were collected and water-level measurements were made twice per year. Two deep monitoring wells were drilled in McBaine Bottoms in 2007--one west of treatment wetland unit 3 (MW-116C) and the other (MW4-2C) adjacent to existing monitoring wells MW4-2A and MW4-2B on the Eagle Bluffs Conservation Area. The largest chloride concentration detected in samples collected during 2007 was 230 milligrams per liter (monitoring well MW4-2B). Chloride concentrations in samples from the deep wells were 213 (monitoring well MW-116C) and 205 milligrams per liter (monitoring well MW4-2C).

Between 2008 and 2012, thirty-seven groundwater samples and 12 surface-water samples were collected and analyzed for wastewater compounds and pharmaceuticals. A total of 34 compounds were detected in groundwater samples, and of those, 14 compounds were found in quantifiable concentrations. In contrast, a total of 56 compounds were detected in surface-water samples, and 33 were found in quantifiable concentrations. The compounds DEET, Bisphenol A, and p-Cresol were the most frequently detected compounds in groundwater with 23, 18, and 11 detections respectively. The compounds 5-Methyl-1H-benzotriazole, Benzophenone, Carbamazepine, Cholesterol, Hexahydrohexamethyl cyclopentabenzopyran, Tributyl phosphate, Triethyl citrate, Tris(2-butoxyethyl) phosphate, and Tris(dichloroisopropyl) phosphate were detected in every surface-water sample.

STUDY AREA

McBaine Bottoms is located 7 miles southwest of Columbia, Missouri, along the north bank of the Missouri River. The area is bounded to the southwest by the Missouri River and to the northeast by Perche Creek. The city of Columbia wastewater treatment wetlands are located along Perche Creek north of the Eagle Bluffs Conservation Area, which occupies the southern part of McBaine Bottoms.

The surficial material underlying the Eagle Bluffs Conservation Area mainly consists of Missouri River alluvium, which is comprised of coarse sand and gravel in the lower part and fine sand, silt, or clay in the upper part. The average saturated thickness is approximately 60 feet.

PURPOSE FOR STUDY

The combination of effluent-enriched groundwater and a groundwater flow pattern that can transport contaminants toward the city of Columbia well field is cause for concern about the potential for introduction of effluent-enriched groundwater into the municipal water supply of Columbia. The purpose of this long-term monitoring plan is to provide the city of Columbia with the information needed to protect the well field and ensure good-quality drinking water for the city.

OBJECTIVE

The objective of this long-term groundwater-monitoring plan is to continue to monitor the water quality throughout McBaine Bottoms to track changes in groundwater quality in the vicinity of the city of Columbia public-supply well field and the Eagle Bluffs Conservation Area. The monitoring wells sampled are those most likely to intercept groundwater flowing from beneath the Eagle Bluffs Conservation Area and the wastewater treatment wetlands toward the city of Columbia well field. This plan includes the routine sampling of selected monitoring wells and surface water sites.

APPROACH

Water samples will be collected from selected monitoring wells adjacent to wetland treatment units (table 1; fig. 1). Wells sampled will be along the flow path between the wetland treatment units and the municipal well field or along the flow path between the Eagle Bluffs Conservation Area and the municipal well field (table 1; fig. 1). The sampling schedule in this work plan is proposed for fiscal years 2018 through 2023.

Beginning in FY 2018, water samples will be collected from the sites in table 1. Physical properties will be determined for all samples; all samples collected will be analyzed for inorganic indicator constituents and nutrient constituents (table 2) in the first quarter and third quarter of the year. Samples will be collected in the third quarter of each fiscal year for pesticide analysis (table 3). In addition to the inorganic and pesticide samples, at the three surface water sites (table 1), samples will be collected for wastewater indicator compounds and pharmaceuticals (table 3).

Every two years, beginning in FY2018, a mass water-level measurement will be made and a water-level map constructed. In addition, every two years, beginning in FY2018, samples for wastewater indicator compounds and pharmaceuticals (table 3) will be collected alternatively to the pesticide samples.

DELIVERABLES

After the validation of all water-level and water-quality data, the data will be provided annually to the City of Columbia. All of the data will be archived in the USGS National Water

Information System database available on the World Wide Web. Additional hard copy or electronic summary of the data will be made available upon request. Annual briefings of study progress will be provided to city of Columbia personnel.

BENEFITS

The data set will help managers and planners assess the magnitude of the potential detrimental effects that effluent-enriched ground and surface water could pose on the municipal supply. Information from this study will help to more efficiently locate new groundwater monitoring sites (if necessary) or identify existing sites that will be monitored in the future to protect this valuable resource.

TIMELINE AND BUDGET

Federal employees trained in the hydrologic sciences will do all fieldwork, data review and processing, and project management in-house. The USGS National Water Quality Laboratory in Denver, Colorado, will complete all laboratory chemical analyses. Periodic review of the data and trends may warrant changes in the focus of the project.

Federal fiscal year	2018				2019				2020				2021				2022				2023			
Sample type and Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Inorganics and nutrients	x				x				x				x				x				x			
Inorganics, nutrients, and pesticides			x								x								x					
Inorganics, nutrients, waste-water indicators, and pharmaceuticals							x								x								x	
Mass water-level measurement			x								x								x					

Federal Fiscal Year	2018	2019	2020	2021	2022	2023
Sample collection, field supplies, and data review	$40,790	$36,120	$43,940	$38,620	$46,610	$45,580
Laboratory and lab supplies	$ 28,760	$ 37,280	$ 30,510	$ 39,530	$ 32,350	$ 41,920
Total	$ 69,550	$ 73,400	$ 74,450	$ 78,150	$ 78,960	$ 87,500

Table 1. Sampling sites.

Site	Site Type	Number of samples per year inorganic(organic)
MW1-2B	GW	2(1)
MW4-2B	GW	2(1)
MW4-2C	GW	2(1)
MW-116	GW	2(1)
MW-116C	GW	2(1)
MW-133	GW	2(1)
MW-133C (new well)	GW	2(1)
USGS-08S	GW	2(0)
MW13-67 (or equivalent new well)	GW	2(1)
Columbia STP outflow	SW	2(1)
Columbia wetland outflow	SW	2(1)
Eagle Bluffs outflow	SW	2(1)
Quality Assurance samples	QA	3(1)
Total		27(12)

Table 2. Inorganic major Ions (USGS schedule 546) and nutrients (USGS Schedule 800).

USGS major ions (USGS schedule 546)

Analyte	Parameter Code	Method	CAS Number	Reporting limit	Unit	RL Type	Container
Acid Neutralizing Capacity (ANC), laboratory	90410	TT040	471-34-1	8	mg/L	lrl	RU
Calcium	915	PLA11	7440-70-2	0.044	mg/L	lrl	FA
Chloride	940	IC022	16887-00-6	0.12	mg/L	lrl	FU
Fluoride	950	ISE05	16984-48-8	0.08	mg/L	lrl	FU
Magnesium	925	PLA11	7439-95-4	0.016	mg/L	lrl	FA
pH, laboratory	403	EL006		0.1	pH	mrl	RU
Potassium	935	PLO03	9/7/7440	0.064	mg/L	lrl	FA
Sodium	930	PLA11	7440-23-5	0.1	mg/L	lrl	FA
specific conductance, laboratory	90095	WHT03		5	uS/cm	mrl	RU
Sulfate	945	IC022	14808-79-8	0.18	mg/L	lrl	FU

Nutrients (USGS schedule 800)

Analyte	Parameter Code	Method	CAS Number	Reporting limit	Unit	RL Type	Container
Nitrogen, ammonia as N (dissolved)	608	48	7664-41-7	0.02	mg/L	lrl	FCC
nitrogen, ammonia + organic nitrogen (total)	625	KJ008	17778-88-0	0.1	mg/L	lrl	WCA
nitrogen, nitrite (dissolved)	613	49	14797-65-0	0.002	mg/L	irl	FCC
nitrogen, nitrite + nitrate (dissolved)	631	CL048		0.04	mg/L	lrl	FCC
Phosphorus (dissolved)	666	KJ005	7723-14-0	0.04	mg/L	lrl	FCC
phosphorus, phosphate, ortho (dissolved)	671	48	14265-44-2	0.008	mg/L	lrl	FCC
Phosphorus (total)	665	KJ009	7723-14-0	0.04	mg/L	lrl	WCA

Table 3. Pesticides (USGS schedule 2001), wastewater organics (USGS schedule 4433), and pharmaceuticals (USGS schedule 2080).

Pesticides (USGS schedule 2001)

Analyte	Parameter code	Method	CAS Number	Reporting level	Unit	RL Type
alpha-HCH	34253	GCM35	319-84-6	0.004	ug/L	lrl
Acetochlor	49260	GCM33	34256-82-1	0.01	ug/L	lrl
Alachlor	46342	GCM35	15972-60-8	0.008	ug/L	lrl
2,6-Diethylaniline	82660	GCM35	579-66-8	0.006	ug/L	irl
Atrazine	39632	GCM35	1912-24-9	0.008	ug/L	lrl
Azinphos-methyl	82686	GCM35	86-50-0	0.12	ug/L	lrl
Benfluralin	82673	GCM35	1861-40-1	0.014	ug/L	lrl
Butylate	4028	GCM35	2008-41-5	0.004	ug/L	lrl
Carbaryl	82680	GCM35	63-25-2	0.06	ug/L	lrl
Carbofuran	82674	GCM35	1563-66-2	0.06	ug/L	lrl
Chlorpyrifos	38933	GCM35	2921-88-2	0.01	ug/L	irl
cis-Permethrin	82687	GCM35	61949-76-6	0.01	ug/L	lrl
Cyanazine	4041	GCM35	21725-46-2	0.022	ug/L	lrl
Dacthal	82682	GCM35	1861-32-1	0.0076	ug/L	lrl
2-Chloro-4-isopropylamino-6-amino-s-triazine {CIAT}	4040	GCM35	6190-65-4	0.01	ug/L	lrl
Diazinon	39572	GCM35	333-41-5	0.006	ug/L	lrl
Diazinon-d10 (surrogate)	91063	GCM35	100155-47-3		pct	
Dieldrin	39381	GCM35	60-57-1	0.008	ug/L	lrl
Disulfoton	82677	GCM35	298-04-4	0.04	ug/L	lrl
EPTC	82668	GCM35	759-94-4	0.0056	ug/L	lrl
Ethalfluralin	82663	GCM35	55283-68-6	0.006	ug/L	lrl
Ethoprophos	82672	GCM35	13194-48-4	0.016	ug/L	lrl
Fipronil	62166	GCM31	120068-37-3	0.018	ug/L	lrl
Desulfinylfipronil amide	62169	GCM31		0.029	ug/L	irl
Fipronil sulfide	62167	GCM31	120067-83-6	0.016	ug/L	lrl
Fipronil sulfone	62168	GCM31	120068-36-2	0.024	ug/L	lrl
Desulfinylfipronil	62170	GCM31		0.012	ug/L	irl
Fonofos	4095	GCM35	944-22-9	0.0048	ug/L	lrl
alpha-HCH-d6 (surrogate)	91065	GCM35	86194-41-4		pct	
Lindane	39341	GCM35	58-89-9	0.004	ug/L	lrl
Linuron	82666	GCM35	330-55-2	0.06	ug/L	lrl
Malathion	39532	GCM35	121-75-5	0.016	ug/L	lrl
Methyl parathion	82667	GCM35	298-00-0	0.008	ug/L	lrl
Metolachlor	39415	GCM35	51218-45-2	0.012	ug/L	lrl
Metribuzin	82630	GCM35	21087-64-9	0.012	ug/L	lrl
Molinate	82671	GCM35	2212-67-1	0.008	ug/L	lrl
Napropamide	82684	GCM35	15299-99-7	0.01	ug/L	lrl
p,p'-DDE	34653	GCM35	72-55-9	0.0048	ug/L	lrl

Analyte	Parameter code	Method	CAS Number	Reporting level	Unit	RL Type
Parathion	39542	GCM35	56-38-2	0.02	ug/L	lrl
Pebulate	82669	GCM35	1114-71-2	0.016	ug/L	lrl
Pendimethalin	82683	GCM35	40487-42-1	0.012	ug/L	lrl
Phorate	82664	GCM35	298-02-2	0.02	ug/L	lrl
Prometon	4037	GCM35	1610-18-0	0.012	ug/L	lrl
Propachlor	4024	GCM35	1918-16-7	0.006	ug/L	lrl
Propanil	82679	GCM35	709-98-8	0.01	ug/L	lrl
Propargite	82685	GCM35	2312-35-8	0.02	ug/L	lrl
Propyzamide	82676	GCM35	23950-58-5	0.008	ug/L	lrl
Simazine	4035	GCM35	122-34-9	0.006	ug/L	lrl
Tebuthiuron	82670	GCM35	34014-18-1	0.028	ug/L	lrl
Terbacil	82665	GCM35	5902-51-2	0.024	ug/L	lrl
Terbufos	82675	GCM35	13071-79-9	0.018	ug/L	lrl
Thiobencarb	82681	GCM35	28249-77-6	0.016	ug/L	lrl
Tri-allate	82678	GCM35	2303-17-5	0.0046	ug/L	lrl
Trifluralin	82661	GCM35	1582-09-8	0.018	ug/L	lrl

Wastewater organics (USGS schedule 4433)

Analyte	Parameter Code	Method	CAS Number	Reporting level	Unit	RL Type
3,4-Dichlorophenyl isocyanate	63145	GCM99	102-36-3	0.32	ug/L	irl
3-beta-Coprostanol	62806	GCM99	360-68-9	1.6	ug/L	irl
4-n-Octylphenol	62809	GCM99	1806-26-4	0.02	ug/L	irl
4-Nonylphenol diethoxylate (NP2EO), all isomers	61703	GCM99	20427-84-3	1.6	ug/L	irl
4-Nonylphenol monoethoxylate (NP1EO), all isomers	61704	GCM99	68412-54-4	1.6	ug/L	irl
4-tert-Octylphenol diethoxylate, aka OP2EO	62486	GCM99	2315-61-9	0.2	ug/L	irl
4-tert-Octylphenol monoethoxylate, aka OP1EO	62485	GCM99	2315-67-5	0.6	ug/L	irl
5-Methyl-1H-benzotriazole	61944	GCM99	136-85-6	0.32	ug/L	irl
Anthraquinone	62813	GCM99	84-65-1	0.04	ug/L	irl
Acetophenone	62811	GCM99	98-86-2	0.4	ug/L	irl
Acetyl hexamethyl tetrahydronaphthalene (AHTN)	62812	GCM99	21145-77-7	0.04	ug/L	irl
Anthracene	34220	GCM99	120-12-7	0.02	ug/L	irl
Atrazine	39630	GCM99	1912-24-9	0.16	ug/L	irl
1,4-Dichlorobenzene	34571	GCM99	106-46-7	0.08	ug/L	irl
Benzo[a]pyrene	34247	GCM99	50-32-8	0.02	ug/L	irl
Benzophenone	62814	GCM99	119-61-9	0.08	ug/L	irl
Bisphenol A-d14 (surrogate)	91748	GCM99			pct	
Bromacil	30234	GCM99	314-40-9	0.16	ug/L	irl
Bromoform	32104	GCM99	75-25-2	0.16	ug/L	irl

Analyte	Parameter Code	Method	CAS Number	Reporting level	Unit	RL Type
3-tert-Butyl-4-hydroxy anisole (BHA)	61702	GCM99	121-00-6	0.16	ug/L	irl
Caffeine	81436	GCM99	58-08-2	0.08	ug/L	irl
Caffeine-d9 (surrogate)	91742	GCM99	72238-85-8		pct	
Camphor	62817	GCM99	76-22-2	0.08	ug/L	irl
Carbaryl	39750	GCM99	63-25-2	0.06	ug/L	irl
Carbazole	77571	GCM99	86-74-8	0.02	ug/L	irl
Chlorpyrifos	38932	GCM99	2921-88-2	0.12	ug/L	irl
Cholesterol	62818	GCM99	57-88-5	1.6	ug/L	irl
Isopropylbenzene	77223	GCM99	98-82-8	0.04	ug/L	irl
Fluoranthene-d10 (surrogate)	62842	GCM99	93951-69-0		pct	
Decafluorobiphenyl (surrogate)	62841	GCM99	434-90-2		pct	
N,N-diethyl-meta-toluamide (DEET)	61947	GCM99	134-62-3	0.04	ug/L	irl
Diazinon	39570	GCM99	333-41-5	0.32	ug/L	irl
Dichlorvos	30218	GCM99	62-73-7	0.08	ug/L	irl
Bisphenol A	62816	GCM99	80-05-7	0.04	ug/L	irl
Triethyl citrate (ethyl citrate)	62833	GCM99	77-93-0	0.04	ug/L	irl
Tetrachloroethylene	34475	GCM99	127-18-4	0.16	ug/L	irl
Fluoranthene	34376	GCM99	206-44-0	0.02	ug/L	irl
Hexahydrohexamethylcyclopentabenzopyran (HHCB)	62823	GCM99	1222-05-5	0.04	ug/L	irl
Indole	62824	GCM99	120-72-9	0.04	ug/L	irl
Isoborneol	62825	GCM99	124-76-5	0.09	ug/L	irl
Isophorone	34408	GCM99	78-59-1	0.05	ug/L	irl
Isoquinoline	62826	GCM99	119-65-3	0.8	ug/L	irl
d-Limonene	62819	GCM99	5989-27-5	0.16	ug/L	irl
Menthol	62827	GCM99	89-78-1	0.32	ug/L	irl
Metalaxyl	4254	GCM99	57837-19-1	0.16	ug/L	irl
Metolachlor	82612	GCM99	51218-45-2	0.04	ug/L	irl
Naphthalene	34696	GCM99	91-20-3	0.02	ug/L	irl
1-Methylnaphthalene	81696	GCM99	90-12-0	0.04	ug/L	irl
2,6-Dimethylnaphthalene	62805	GCM99	581-42-0	0.04	ug/L	irl
2-Methylnaphthalene	30194	GCM99	91-57-6	0.04	ug/L	irl
p-Cresol	77146	GCM99	106-44-5	0.08	ug/L	irl
4-Cumylphenol	62808	GCM99	599-64-4	0.04	ug/L	irl
para-Nonylphenol (total) (branched)	62829	GCM99	84852-15-3	1.6	ug/L	irl
4-tert-Octylphenol	62810	GCM99	140-66-9	0.4	ug/L	irl
2,2',4,4'-Tetrabromodiphenylether (PBDE 47)	63147	GCM99	5436-43-1	0.04	ug/L	irl
Phenanthrene	34461	GCM99	85-01-8	0.02	ug/L	irl
Phenol	34694	GCM99	108-95-2	0.16	ug/L	irl
Pentachlorophenol	39032	GCM99	87-86-5	1.6	ug/L	irl
Tributyl phosphate	62832	GCM99	126-73-8	0.064	ug/L	irl

Analyte	Parameter Code	Method	CAS Number	Reporting level	Unit	RL Type
Triphenyl phosphate	62834	GCM99	115-86-6	0.08	ug/L	irl
Tris(2-butoxyethyl)phosphate	62830	GCM99	78-51-3	0.64	ug/L	irl
Tris(2-chloroethyl)phosphate	62831	GCM99	115-96-8	0.16	ug/L	irl
Bis(2-ethylhexyl) phthalate	39100	GCM99	117-81-7	2	ug/L	irl
Diethyl phthalate	34336	GCM99	84-66-2	0.4	ug/L	irl
Prometon	39056	GCM99	1610-18-0	0.16	ug/L	irl
Pyrene	34469	GCM99	129-00-0	0.02	ug/L	irl
Methyl salicylate	62828	GCM99	119-36-8	0.08	ug/L	irl
Sample volume	99963	GCM99			mL	
3-Methyl-1(H)-indole (Skatole)	62807	GCM99	83-34-1	0.04	ug/L	irl
beta-Sitosterol	62815	GCM99	83-46-5	4.8	ug/L	irl
beta-Stigmastanol	61948	GCM99	19466-47-8	3.4	ug/L	irl
Triclosan	61708	GCM99	3380-34-5	0.32	ug/L	irl
Tris(dichloroisopropyl)phosphate	61707	GCM99	13674-87-8	0.32	ug/L	irl

Pharmaceuticals (USGS schedule 2440)

Analyte	Parameter Code	M	CAS Number	Reporting level	Unit	RL Type
Abacavir	68022	LCM56	136470-78-5	8.2	ng/L	RLDQC
Acetaminophen	67436	LCM56	103-90-2	20	ng/L	RLDQC
acetaminophen-d3 (surrogate)	91775	LCM56			pct	
Acyclovir	67484	LCM56	59277-89-3	22	ng/L	RLDQC
Albuterol	67437	LCM56	18559-94-9	6.7	ng/L	RLDQC
albuterol-d9 (surrogate)	91772	LCM56			pct	
Alprazolam	68250	LCM56	28981-97-7	21	ng/L	RLDQC
Amitriptyline	67522	LCM56	50-48-6	37	ng/L	RLDQC
10-Hydroxy-amitriptyline	67995	LCM56	64520-05-4	8.3	ng/L	RLDQC
Amphetamine	67461	LCM56	300-62-9	8.1	ng/L	RLDQC
amphetamine-d6 (surrogate)	91784	LCM56			pct	
Antipyrine	67477	LCM56	60-80-0	116	ng/L	RLDQC
Atenolol	67502	LCM56	29122-68-7	13	ng/L	RLDQC
Atrazine	65065	LCM56	1912-24-9	19	ng/L	RLDQC
Benztropine	67997	LCM56	86-13-5	44	ng/L	RLDQC
Betamethasone	67485	LCM56	378-44-9	114	ng/L	RLDQC
Bupropion	67439	LCM56	34911-55-2	18	ng/L	RLDQC
Caffeine	67440	LCM56	58-08-2	91	ng/L	RLDQC
caffeine (trimethyl-13C3) (surrogate)	91781	LCM56			pct	
Carbamazepine	67441	LCM56	298-46-4	11	ng/L	RLDQC
Carisoprodol	67498	LCM56	78-44-4	50	ng/L	RLDQC
Chlorpheniramine	67497	LCM56	132-22-9	54	ng/L	RLDQC
Cimetidine	67442	LCM56	51481-61-9	42	ng/L	RLDQC
Citalopram	67505	LCM56	59729-33-8	6.6	ng/L	RLDQC
Clonidine	67518	LCM56	4205-90-7	61	ng/L	RLDQC

Analyte	Parameter Code	M	CAS Number	Reporting level	Unit	RL Type
Codeine	67443	LCM56	76-57-3	88	ng/L	RLDQC
Codeine-d6 (surrogate)	91786	LCM56	371151-94-9		pct	
Cotinine	67444	LCM56	486-56-6	6.4	ng/L	RLDQC
cotinine-d3 (surrogate)	91783	LCM56			pct	
Dehydronifedipine	67445	LCM56	67035-22-7	30	ng/L	RLDQC
Desmethyldiltiazem	67999	LCM56		70	ng/L	RLDQC
desvenlafaxine	68251	LCM56	93413-62-8	84	ng/L	RLDQC
Dextromethorphan	67468	LCM56	125-71-3	8.2	ng/L	RLDQC
Diazepam (valium)	67499	LCM56	439-14-5	4	ng/L	RLDQC
Diazepam-d5 surrogate (surrogate)	91790	LCM56	65854-76-4		pct	
Diltiazem	67519	LCM56	42399-41-7	10	ng/L	RLDQC
diltiazem-d3 (surrogate)	91773	LCM56			pct	
1,7-Dimethylxanthine (p-Xanthine)	67446	LCM56	611-59-6	88	ng/L	RLDQC
Diphenhydramine	67447	LCM56	147-24-0	19	ng/L	RLDQC
Diphenhydramine-d3 (surrogate)	91788	LCM56			pct	
Duloxetine	67448	LCM56	116539-59-4	37	ng/L	RLDQC
Erythromycin	67449	LCM56	114-07-8	80	ng/L	RLDQC
Ezetimibe	67487	LCM56	163222-33-1	205	ng/L	RLDQC
Fadrozole	68012	LCM56	102676-47-1	13	ng/L	RLDQC
Famotidine	68000	LCM56	76824-35-6	34	ng/L	RLDQC
Fenofibrate	67489	LCM56	49562-28-9	14	ng/L	RLDQC
Fexofenadine	67510	LCM56	83799-24-0	96	ng/L	RLDQC
Fluconazole	67478	LCM56	86386-73-4	71	ng/L	RLDQC
Fluoxetine	67450	LCM56	54910-89-3	27	ng/L	RLDQC
Fluoxetine-d6 (surrogate)	91789	LCM56			pct	
Fluticasone propionate	67529	LCM56	80474-14-2	4.6	ng/L	RLDQC
Fluvoxamine	67521	LCM56	54739-18-3	80	ng/L	RLDQC
Gabapentin	52817	LCM56	60142-96-3	400	ng/L	irl
Glipizide	68001	LCM56	29094-61-9	80	ng/L	RLDQC
Glyburide	68002	LCM56	10238-21-8	58	ng/L	RLDQC
Guanylurea	52816	LCM56	141-83-3	400	ng/L	irl
Hexamethylenetetramine	52815	LCM56	100-97-0	40	ng/L	irl
Hydrocodone	67506	LCM56	125-29-1	10	ng/L	RLDQC
hydrocodone-d3 (surrogate)	91779	LCM56			pct	
Hydrocortisone	67459	LCM56	50-23-7	147	ng/L	RLDQC
Hydroxyzine	68005	LCM56	68-88-2	7.4	ng/L	RLDQC
Iminostilbene	67481	LCM56	256-96-2	145	ng/L	RLDQC
Ketoconazole	68014	LCM56	65277-42-1	113	ng/L	RLDQC
Lamivudine	68018	LCM56	134678-17-4	16	ng/L	RLDQC
Lidocaine	67462	LCM56	137-58-6	38	ng/L	RLDQC
Loperamide	67515	LCM56	53179-11-6	80	ng/L	RLDQC
Loratadine	67488	LCM56	79794-75-5	7	ng/L	RLDQC
Lorazepam	67470	LCM56	846-49-1	202	ng/L	RLDQC
Meprobamate	67464	LCM56	57-53-4	86	ng/L	RLDQC

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Metaxalone	67504	LCM56	1665-48-1	16	ng/L	RLDQC
Metformin	67492	LCM56	657-24-9	13	ng/L	RLDQC
Metformin-d6 (surrogate)	90395	LCM56			pct	
Methadone	67500	LCM56	76-99-3	7.6	ng/L	RLDQC
methadone-d9 (surrogate)	91777	LCM56			pct	
methocarbamol	67501	LCM56	532-03-6	11	ng/L	RLDQC
Methotrexate	67525	LCM56	59-05-2	52	ng/L	RLDQC
methyl-1H-benzotriazole	67514	LCM56	29385-43-1	80	ng/L	RLDQC
Metoprolol	67523	LCM56	51384-51-1	27	ng/L	RLDQC
Morphine	67458	LCM56	57-27-2	80	ng/L	RLDQC
Nadalol	68006	LCM56	42200-33-9	20	ng/L	RLDQC
Nevirapine	68017	LCM56	129618-40-2	290	ng/L	RLDQC
nicotine	67493	LCM56	54-11-5	58	ng/L	RLDQC
Nizatidine	67479	LCM56	76963-41-2	80	ng/L	RLDQC
Nordiazepam	68252	LCM56	1088-11-5	20	ng/L	RLDQC
Norethindrone	67434	LCM56	68-22-4	20	ng/L	RLDQC
Norfluoxetine	67451	LCM56	56161-73-0	80	ng/L	RLDQC
norfluoxetine-d6 (surrogate)	91776	LCM56			pct	
Norsertraline	67532	LCM56	87857-41-8	80	ng/L	RLDQC
Norverapamil	68007	LCM56	67018-85-3	8.6	ng/L	RLDQC
Omeprazole + Esomprazole	67512	LCM56		16	ng/L	RLDQC
Oseltamivir	67511	LCM56	196618-13-0	15	ng/L	RLDQC
Oxazepam	67469	LCM56	604-75-1	226	ng/L	RLDQC
Oxycodone	67495	LCM56	76-42-6	25	ng/L	RLDQC
oxycodone-d3 (surrogate)	91778	LCM56			pct	
Paroxetine	67527	LCM56	61869-08-7	264	ng/L	RLDQC
Penciclovir	68021	LCM56	39809-25-1	80	ng/L	RLDQC
Pentoxifylline	67480	LCM56	5/6/6493	9.4	ng/L	RLDQC
Phenazopyridine	68008	LCM56	94-78-0	13	ng/L	RLDQC
Phendimetrazine	67496	LCM56	634-03-7	31	ng/L	RLDQC
Phenytoin	67466	LCM56	57-41-0	188	ng/L	RLDQC
Piperonyl butoxide	67435	LCM56	51-03-6	20	ng/L	RLDQC
Prednisolone	67483	LCM56	50-24-8	150	ng/L	RLDQC
Prednisone	67467	LCM56	53-03-2	168	ng/L	RLDQC
Promethazine	67524	LCM56	60-87-7	80	ng/L	RLDQC
Propoxyphene	68009	LCM56	469-62-5	17	ng/L	RLDQC
Propranolol	67516	LCM56	525-66-6	26	ng/L	RLDQC
Pseudoephedrine + Ephedrine	67460	LCM56		11	ng/L	RLDQC
Pseudoephedrine-d3 surrogate (surrogate)	91787	LCM56			pct	
Quinine	68011	LCM56	130-95-0	80	ng/L	RLDQC

Analyte	Parameter Code	M	CAS Number	Reporting level	Unit	RL Type
Ractopamine	52814	LCM56	97825-25-7	40	ng/L	irl
Raloxifene	67530	LCM56	84449-90-1	80	ng/L	RLDQC
Ranitidine	67452	LCM56	66357-35-5	192	ng/L	RLDQC
Sertraline	67528	LCM56	79617-96-2	16	ng/L	RLDQC
Sitagliptin	67531	LCM56	486460-32-6	97	ng/L	RLDQC
Sulfadimethoxine	67503	LCM56	122-11-2	65	ng/L	RLDQC
Sulfamethizole	67476	LCM56	144-82-1	104	ng/L	RLDQC
Sulfamethoxazole	67454	LCM56	723-46-6	26	ng/L	RLDQC
sulfamethoxazole-(phenyl-13C6) (surrogate)	91782	LCM56			pct	
Tamoxifen	68015	LCM56	10540-29-1	270	ng/L	MRL
Temazepam	67471	LCM56	846-50-4	18	ng/L	RLDQC
temazepam-d5 (surrogate)	91780	LCM56			pct	
theophylline	67494	LCM56	58-55-9	80	ng/L	RLDQC
Thiabendazole	67455	LCM56	148-79-8	11	ng/L	RLDQC
thiabendazole-d4 (surrogate)	91769	LCM56			pct	
Tiotropium	67508	LCM56	186691-13-4	200	ng/L	RLDQC
Tramadol	67517	LCM56	27203-92-5	15	ng/L	RLDQC
Triamterene	67475	LCM56	396-01-0	5.2	ng/L	RLDQC
Trimethoprim	67456	LCM56	738-70-5	19	ng/L	RLDQC
trimethoprim-d9 (surrogate)	91774	LCM56			pct	
Valacyclovir	67507	LCM56	124832-26-4	163	ng/L	RLDQC
Venlafaxine	67534	LCM56	93413-69-5	5.2	ng/L	RLDQC
Verapamil	67472	LCM56	52-53-9	140	ng/L	RLDQC
Warfarin	67457	LCM56	81-81-2	6	ng/L	RLDQC